Marine Bird Winter Surveys in Prince William Sound

March 12, 2025

MA Bishop and A Schaefer

Prince William Sound Science Center, PO Box 705, Cordova, AK

Contract 9110. 25. 01

Contents

Acronym List

ERMA: Environmental Response Management Application, NOAA

ESI: Environmental Sensitivity Index, NOAA

EVOS: Exxon Valdez oil spill

EVOSTC: *Exxon Valdez* Oil Spill Trustee Council

GPS: Global positioning system

GWA: Gulf Watch Alaska, a survey program funded by EVOSTC

km: Kilometers

m: Meters

NOAA: National Oceanic and Atmospheric Administration

PWS: Prince William Sound

PWSRCAC: Prince William Sound Regional Citizens' Advisory Council

s: Second

USFWS: U.S. Fish and Wildlife Service

Executive Summary

Of the marine birds that overwinter in Prince William Sound (PWS), Alaska, nine species and one species group were initially injured by the 1989 Exxon Valdez oil spill (EVOS; *Exxon Valdez* Oil Spill Trustee Council, 2014). This Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) commissioned study, now in its fourth year, conducted marine bird and marine mammal surveys in and around the PWS tanker escort zone and the Alyeska Pipeline Service Company's Valdez Marine Terminal. Our study objective is to determine distribution and density of marine birds and mammals during the nonbreeding season in this under-surveyed area. Our surveys are designed to complement the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) funded Gulf Watch Alaska (GWA) surveys conducted from 2007-2022 by the PWS Science Center.

We conducted at-sea transect surveys between September 9–10, 2024 (fall), and November 11-14, 2024 (early winter), using the PWS Science Center's research motor vessel, the New Wave. Transects varied in length from 7.4 kilometers (km) (Rocky Bay) to 29.2 km (Port Valdez). For each transect we recorded all marine birds and marine mammals observed within a 300-meter (m) survey strip. In September, 1551 birds representing 26 species were counted across the 11 transects. Black-legged kittiwake (*Rissa tridactyla*) was the most abundant species (61.1% of observations), followed by glaucous-winged gull (*Larus glaucescens*, 17.8%) and marbled murrelet (*Brachyramphus marmoratus*, 5.4%). Beginning in November, we added a transect around the Knowles Head tanker anchorage. During November surveys, a total of 796 birds (28 species) were counted across the 12 transects. Pelagic cormorant (*Urile pelagicus,* 13.1%) was the most abundant species, followed by two waterfowl species, white-winged scoter (*Melanitta fusca*, 11.2 %) and common goldeneye (*Bucephala clangula* 9. 9%). For both September and November surveys, observations of marine mammals were dominated by sea otter (*Enhydra lutris*).

The September and November 2024 results provide further support for special protection of the marine and nearshore waters around the head of Port Valdez as well as the bays and island coastlines around Hinchinbrook Entrance. These two areas host consistently high numbers of marine birds and marine mammals, including species that have yet to recover from the 1989 oil spill. Importantly, the head of Port Valdez is vulnerable to disturbance due to the proximity to human infrastructure, including the Valdez Marine Terminal, harbor, and fuel dock. Hinchinbrook Entrance is also particularly vulnerable to anthropogenic disturbance because it is where tankers enter and exit PWS and because of the importance of Porpoise Rocks to marine wildlife. Our surveys do not include all areas that potentially may be impacted by an oil spill, nor do they capture all the variations in marine bird phenology, species composition, and habitat use across the nonbreeding season. With that said, continued monitoring in and around the tanker escort lane is important for understanding marine bird and marine mammal vulnerability to environmental change and anthropogenic disturbance and could be used to update oil spill response planning tools and refine response efforts during the non-breeding season.

Introduction

In Alaska, and specifically Prince William Sound (PWS), most studies on marine birds have been conducted during the breeding season when birds congregate at or near colonies to nest and forage. However, breeding season dynamics are not representative of the community composition or spatial distribution during the fall and winter. The non-breeding season is a critical period of survival for marine birds overwintering at higher latitudes as food tends to be relatively scarce or inaccessible, the climate more extreme, light levels and day-length reduced, and water temperatures cooler.

From 2007-2022, as part of the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) funded Gulf Watch Alaska (GWA) program, personnel from the PWS Science Center conducted marine bird surveys in PWS during fall and winter (September – March). Results from 15 seasons of fall/winter surveys demonstrated seasonal differences for all 11 focal avian species groups, indicating movements into and out of PWS over the course of the non-breeding season (Schaefer and Bishop, 2023). For the most abundant marine bird species, including common murre (*Uria aalge*), marbled murrelet (*Brachyramphus marmoratus*), black-legged kittiwake (*Rissa tridactyla*), and large gulls (*Larus* spp.), consistent temporal and spatial patterns were documented (Zuur et al. 2012; Dawson et al. 2015; Stocking et al. 2018; Schaefer et al. 2020; Schaefer and Bishop 2023).

Nevertheless, many regions of PWS remain under-surveyed during winter, including the areas in and around the Alyeska Pipeline Service Company's Valdez Marine Terminal and the associated tanker escort zone. To address this information need, the Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) contracted with the PWS Science Center to conduct marine bird and marine mammal surveys in areas in and around the PWS tanker escort zone, Valdez Arm, and Port Valdez. From 2021-2023, fixed-transect surveys were conducted during late winter (March).

Beginning in 2024, the fixed-transect surveys were conducted during fall and early winter to address intra-seasonal differences within the nonbreeding season. This report describes the density, distribution, and community composition of marine birds and marine mammals during September and November 2024 fixed-transect surveys in and around the Valdez Marine Terminal and the PWS tanker escort zone. The report compares the September and November PWSRCAC transect results with seasonal patterns previously identified during the 15 years of EVOSTC GWA transects. Lastly, our report provides recommendations for prioritizing oil spill response efforts in and around the tanker escort during September and November.

Methods

At-sea marine bird and mammal transect surveys were conducted during daylight hours in September (fall) and November (early winter) and followed established U.S. Fish and Wildlife Service (USFWS) protocols (USFWS 2007). We repeated the same 11 fixed-transects

as the March 2023 surveys. Beginning with the November 2024 survey, we added a transect by Knowles Head (13.7 kilometer (km)) because of its proximity to a tanker anchorage (Figure 1). The Knowles Head transect area had previously been surveyed as part of the EVOSTC GWA program that ended in 2022.

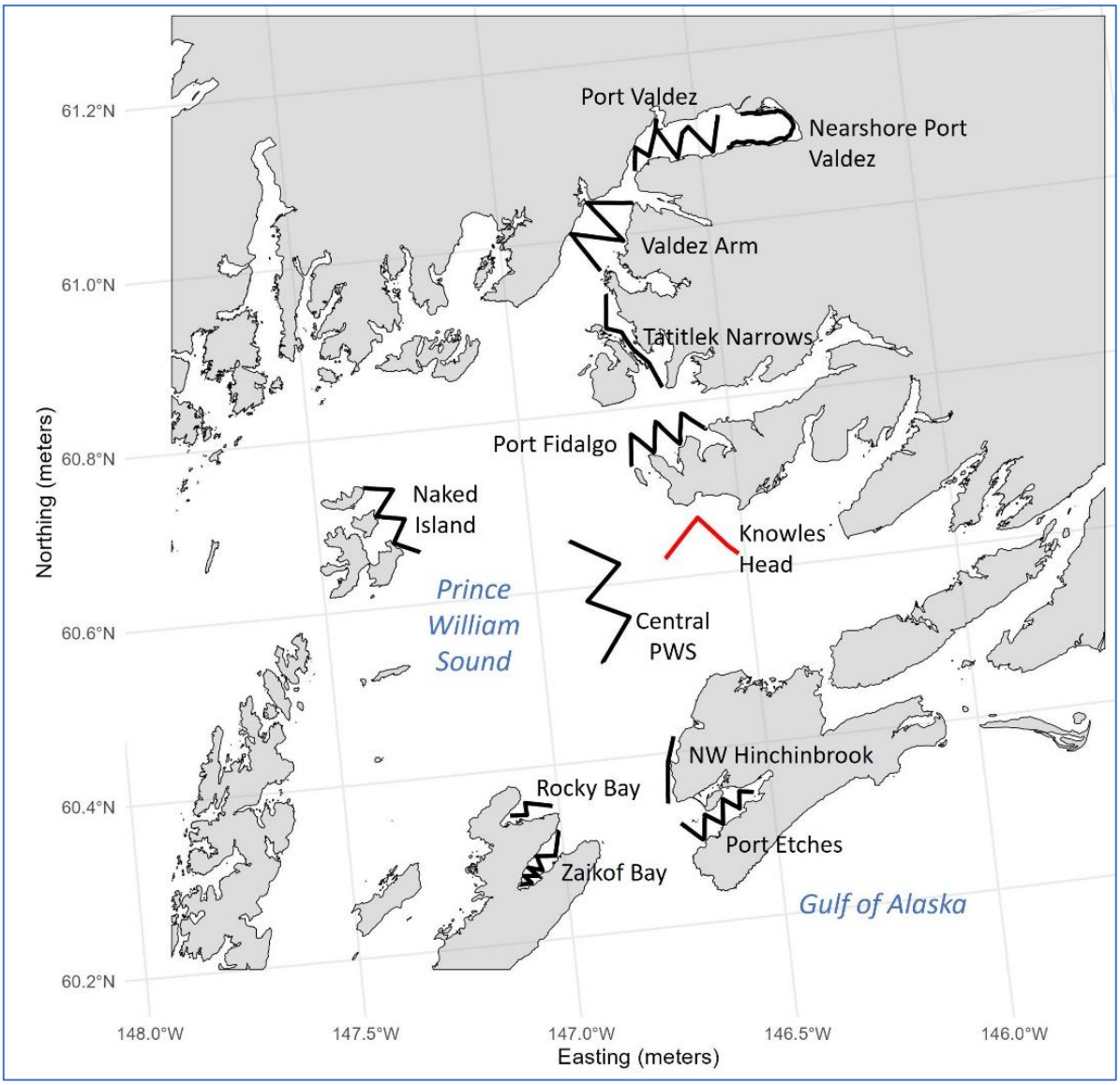

Figure 1. Map of marine bird and marine mammal transects in and around the tanker escort zone surveyed in PWS, September and November 2024. The Knowles Head transect (red) was added in November 2024 and was previously surveyed as part of the EVOSTC GWA program that ended in March 2022.

For the surveys, one observer using 10x binoculars recorded the number, species, and behavior of all marine birds and mammals occurring within a 300-meter (m) fixed-width strip (150-m both sides and ahead of boat) from an observation platform mounted on the New Wave, ~3 m above the water line. The survey vessel traveled at a constant speed between 5 and 10 knots. Marine mammals and forage flocks with >10 birds, were recorded out to 1 km. Observations were recorded into a laptop computer integrated with a global positioning system (GPS) using the program SeaLog (ABR, Inc). Location data (latitude, longitude) were automatically recorded at 15-second (s) intervals and for every entered observation. Additionally, sea state and weather conditions were tracked on-site by the observer.

Following the standard methods used for seabird survey data processing across the region, we divided each transect into 3-km segments and aggregated marine bird observations within each segment for summary. We grouped taxonomically similar species into 12 groups (Table 1) and calculated relative density (birds/km^2) for each 3-km segment. We then averaged ($\pm$ standard deviation) all segments for each transect. Data processing was performed using the program QA/QSea (ABR, Inc) and analyzed using the program R v. 4.4.1 (R Core Team, 2024). Marine mammals were not aggregated by 3-km segment, but are presented as total recorded along the transect and the total recorded beyond the survey strip out to 1-km.

Table 1. Taxonomically similar focal marine bird species combined for density analysis and mapping, PWS, Alaska.

Species group	**Common Name(s)**
Loons	Common, Pacific, Yellow-billed
Grebes	Horned, Red-necked
Cormorants	Double-crested, Pelagic
Deep Diving Ducks	Long-tailed Duck; Surf, White-winged, & Black Scoters
Inshore Ducks	Barrow's & Common Goldeneyes, Bufflehead, Harlequin Duck
Mergansers	Common, Red-breasted
Large Gulls	Glaucous-winged, American Herring, Glaucous
Small Gulls	Short-billed, Bonaparte
Kittiwakes	Black-legged
Murres	Common
Murrelets	Marbled
Guillemots	Pigeon

Results & Discussion

Marine bird and marine mammal transect surveys were conducted in and around the PWS tanker escort zone and Valdez Marine Terminal from September 9–10, 2024 (fall), and November 11-14, 2024 (early winter) (Figure 1). Overall, we surveyed 210 km in September (n = 11 transects) and 221 km in November (n = 12 transects; Table 2). Data from the 2024 survey will be uploaded to the Alaska Ocean Observing System data portal and will be available at https://gulf-of-alaska.portal.aoos.org/#metadata/771492cd-94b6-47ab-952a-02b152a535cf/project/files following proper data and metadata quality controls.

Marine Birds

In September 2024, we recorded 1551 birds representing 26 species within the 300-m survey strip across the 11 PWSRCAC transects (Table 3). Across all areas, the highest densities of marine birds occurred in Port Valdez, and at northern Montague Island's Rocky and Zaikof Bays (Table 2, Figure 2). Three of the recorded species - Bonaparte's gull *Chroicocephalus philadelphia*, red-necked phalarope *Phalaropus lobatus*, and parasitic jaeger *Stercorarius parasiticus* - breed locally but migrate south in fall and were not recorded on the subsequent November 2024 surveys.

On our September surveys, the black-legged kittiwake was the dominant species (61.1% of observations), followed by glaucous-winged gull (*Larus glaucescens*, 17.8%) and marbled murrelet (5.4%; Table 3). Distributions of both black-legged kittiwake and glaucous-winged gull were widespread, with each species occurring on all 11 transects (Figures A-8, A-9). Highest densities for kittiwake and glaucous-winged gull were recorded on the nearshore Port Valdez transect, located at the head of the bay (Table 2, Figure 2).

In November 2024, we recorded 796 birds representing 28 species on the 12 PWSRCAC transects (Table 3). The arrival of wintering birds including Pacific loons (*Gavia pacifica*), pelagic cormorants (*Urile pelagicus*), grebes, mergansers, inshore ducks, and deep diving ducks was evident (Table 3; Appendix A). In November, the most recorded species across all transects was the pelagic cormorant (13.1% of observations) followed by two waterfowl species, white-winged scoter (*Melanitta fusca*, 11.2 %) and common goldeneye (*Bucephala clangula*, 9.9%). Distribution of pelagic cormorants was widespread, occurring on all but the deep-water central PWS transect. Highest cormorant densities were recorded on the nearshore Port Valdez transect, located at the head of the bay (Table 2; Figure A-3). In contrast, both the white-winged scoter and common goldeneyes occurred on only 5 and 3 of the 12 transects, respectively. However, like the cormorants, the highest densities of common goldeneyes occurred on the nearshore Port Valdez transect, while for white-winged scoters highest densities were observed nearby on the Port Valdez zig zag transect (Figures A-4, A-5).

Table 2. Average (± SD) density of marine birds and marine mammals by survey month and transect. PWS, Alaska. Sep = September; Nov = November. * = Knowles Head transect added November 2024.

Transect Name	Km Length, (no. segments) Sep, Nov	X birds/km^2, (SD) Sep	X birds/km^2, (SD) Nov	Mammals, (w/in 1 km) Sep	Mammals, (w/in 1 km) Nov
Central	26.2 (8), 26.2 (8)	0.4 (0.6)	1.7 (1.6)	0 (0)	0 (0)
Port Etches	19.6 (6), 19.3 (6)	14.0 (5.3)	13.1 (7.8)	5 (37)	23 (85)
Port Fidalgo	24.0 (8), 23.8 (8)	5.2 (4.2)	5.0 (3.8)	2 (8)	6 (2)
Knowles Head*	0 (0), 13.7 (4)	-	13.5 (10.9)	-	5 (3)
Naked Island	18.6 (6), 18.0 (5)	16.3 (20.9)	4.0 (4.7)	1 (0)	0 (0)
NW Hinchinbrook Id.	8.6 (2), 8.7 (2)	12.2 (15.7)	5.8 (5.0)	0 (0)	3 (6)
Nearshore Port Valdez	18.3 (6), 18.4 (6)	151.6 (121.0)	40.5 (40.6)	44 (10)	16 (9)
Port Valdez	29.2 (10), 28.2 (9)	9.5 (8.9)	10.8 (23.0)	34 (19)	12 (4)
Rocky Bay	7.5 (2), 7.4 (2)	28.9 (0.5)	5.7 (1.7)	1 (2)	2 (1)
Tatitlek Narrows	15.4 (5), 15.4 (5)	12.1 (6.4)	10.8 (8.7)	13 (42)	12 (7)
Valdez Arm	25.7 (8), 25.7 (8)	3.6 (2.7)	1.3 (2.7)	10 (4)	2 (1)
Zaikof Bay	16.7 (6), 16.1 (5)	35.9 (20.6)	17.5 (8.9)	9 (12)	26 (7)

Among the 11 transects surveyed in September and November, the highest bird densities (birds/km^2) during both surveys were recorded on the nearshore Port Valdez transect located at the head of that bay (September = 151.6 birds/km^2; November = 40.5 birds/km^2). The high densities recorded during September were due to high numbers of black-legged kittiwake and glaucous-winged gull. While not included in the survey count, almost 7500 glaucous-winged and unidentified gulls were also observed near this transect suggesting that either the gulls were staging for migration, or gulls were there to forage at the Solomon Gulch Fish Hatchery and/or around the outflow of the Lowe River. Zaikof Bay at Hinchinbrook Entrance had the second highest densities recorded during both September and November surveys. Densities on the four transects around Hinchinbrook Entrance were relatively high compared to other areas and ranged from 12.2 birds/km^2 along the northwest Hinchinbrook Island transect to 35.9 birds/km^2 at Zaikof Bay in September. Densities around Hinchinbrook Entrance transects during November were much lower and ranged from 5.7 birds/km^2 at Rocky Bay to 17.5 birds/km^2 at Zaikof Bay (Table 2, Figure 2).

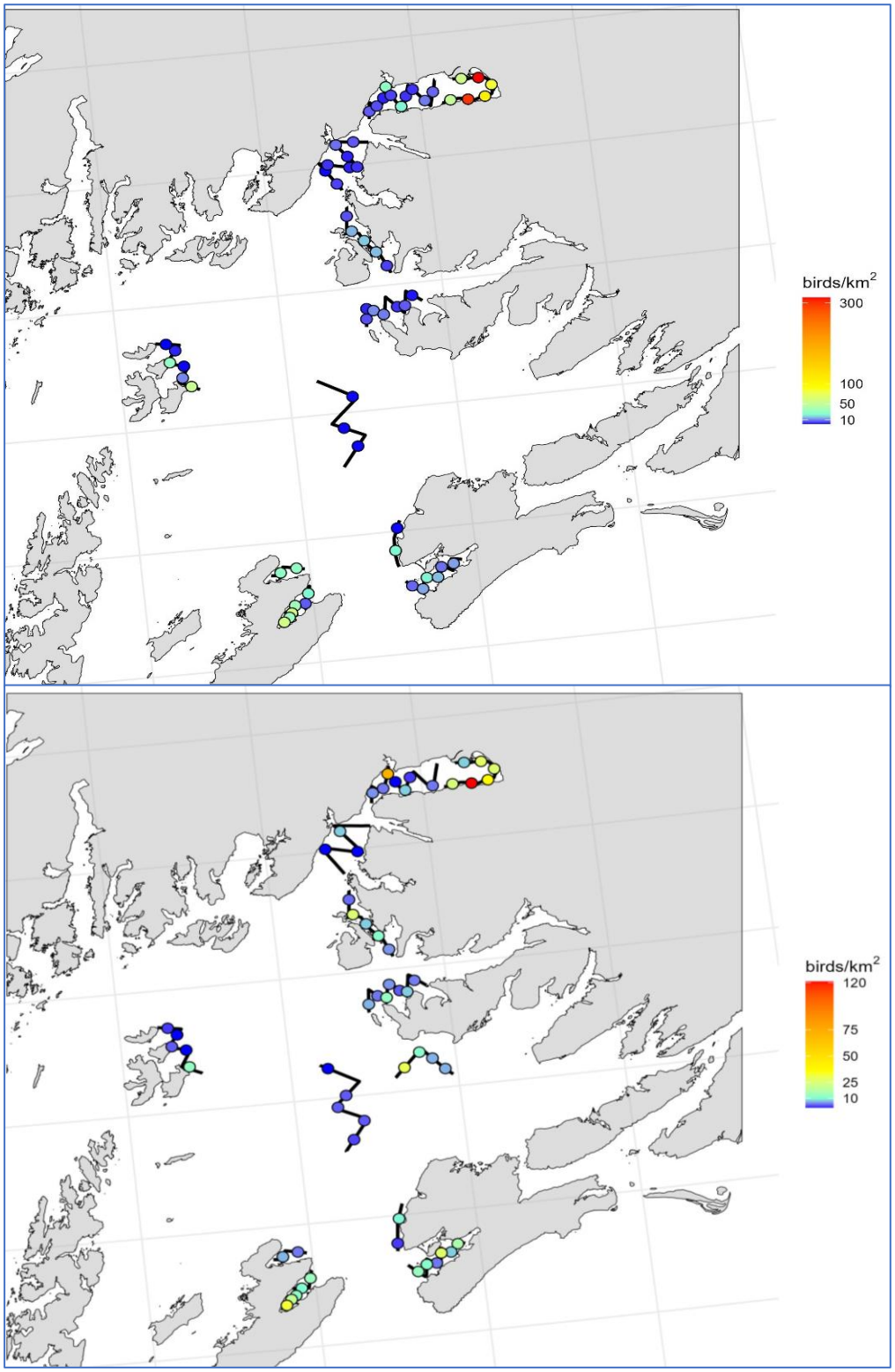

Figure 2. Density (birds/km^2) and distribution of marine birds observed on fixed-transects during September (top) and November (bottom) 2024. Note that the scales are different for each map.

Table 3. Total number of birds observed by species on 300-m PWSRCAC transects. September (Sep) and November (Nov) 2024, PWS, Alaska. Please refer to Appendix A for density and distribution of each species group.

Common name	Scientific name	Count Sep	Count Nov
American Crow	*Corvus brachyrhynchos*	4	1
American Herring Gull	*Larus argentatus smithsonianus*	1	3
American Wigeon	*Mareca americana*	5	0
Ancient Murrelet	*Synthliboramphus antiquus*	2	0
Bald Eagle	*Haliaeetus leucocephalus*	1	2
Barrow's Goldeneye	*Bucephala islandica*	0	3
Black-legged Kittiwake	*Rissa tridactyla*	947	65
Black Oystercatcher	*Haematopus bachmani*	4	0
Black Scoter	*Melanitta americana*	0	1
Bonaparte's Gull	*Chroicocephalus philadelphia*	14	0
Brachyramphus Murrelet		3	4
Bufflehead	*Bucephala albeola*	0	13
Canada Goose	*Branta canadensis*	1	0
Common Goldeneye	*Bucephala clangula*	4	79
Common Merganser	*Mergus merganser*	0	20
Common Murre	*Uria aalge*	29	28
Double-crested Cormorant	*Nannopterum auritum*	7	6
Fork-tailed Storm-Petrel	*Hydrobates furcatus*	4	1
Glaucous-winged Gull	*Larus glaucescens*	276	76
Harlequin Duck	*Histrionicus histrionicus*	8	2
Horned Grebe	*Podiceps auritus*	7	21
Long-tailed Duck	*Clangula hyemalis*	0	7
Marbled Murrelet	*Brachyramphus marmoratus*	84	64
Northern Pintail	*Anas acuta*	0	2
Parasitic Jaeger	*Stercorarius parasiticus*	1	0
Pacific Loon	*Gavia pacifica*	3	33
Pelagic Cormorant	*Urile pelagicus*	25	104
Pigeon Guillemot	*Cepphus columba*	6	4
Red-breasted Merganser	*Mergus serrator*	0	4
Red-necked Grebe	*Podiceps grisegena*	0	2
Red-necked Phalarope	*Phalaropus lobatus*	14	0
Rock Sandpiper	*Calidris ptilocnemis*	0	70
Short-billed Gull	*Larus brachyrhynchus*	45	56

Surf Scoter	*Melanitta perspicillata*	43	29
Unidentified Alcid		1	0
Unidentified Auklet		1	0
Unidentified Cormorant		1	1
Unidentified Goldeneye		0	3
Unidentified Large Gull		2	0
Unidentified Loon		1	1
Unidentified Merganser		0	1
Unidentified Scoter		4	0
White-winged Scoter	*Melanitta deglandi*	2	89
Yellow-billed Loon	*Gavia adamsii*	1	1
Grand Total		1551	796

Forage flocks were observed during both surveys with black-legged kittiwake the dominant species. During September 2024, we recorded two forage flocks including one at Naked Island (35 kittiwakes, 5 common murres) and one on the Port Valdez zigzag transect (46 kittiwakes). In November we recorded a small forage flock at Naked Island (10 kittiwakes, 1 glaucous-winged gull). There were no marine mammals associated with any of these forage flocks.

We compared species composition from the September and November 2024 PWSRCAC surveys to the previous 15 years of September-October and November-December GWA surveys. In fall, species composition was generally similar between the two datasets. Kittiwakes were consistently the most numerous on both PWSRCAC and GWA fall surveys. This was to be expected as there are at least 20 active kittiwake colonies in the Sound, including four colonies in Port Valdez (D. Irons, unpubl. data). The November drop in kittiwake numbers matched seasonal patterns previously observed as by early winter most kittiwake have departed for offshore wintering habitats (McKnight et al., 2011). Glaucous-winged gulls were among the most abundant species during both September and November GWA and PWSRCAC surveys. Glaucous-winged gulls have numerous colonies in PWS and the Copper River Delta (Seabirds.Net: North Pacific Seabird Portal), and are intimately connected with commercial fish processing activities. Although still numerous in PWS, the species begins to migrate as early as late August, and by the end of October many have migrated south to areas ranging from coastal southeast Alaska to northwestern Mexico (Hayward and Verbeek 2008).

Murres were remarkably less abundant in both the September and November PWSRCAC surveys compared with the historic GWA surveys (Figure 3). The reduced number of murres observed in fall and early-winter 2024 is likely due to lingering impacts of the Pacific Marine Heatwave. Throughout the Gulf of Alaska, this prolonged heatwave (2014-2016) led

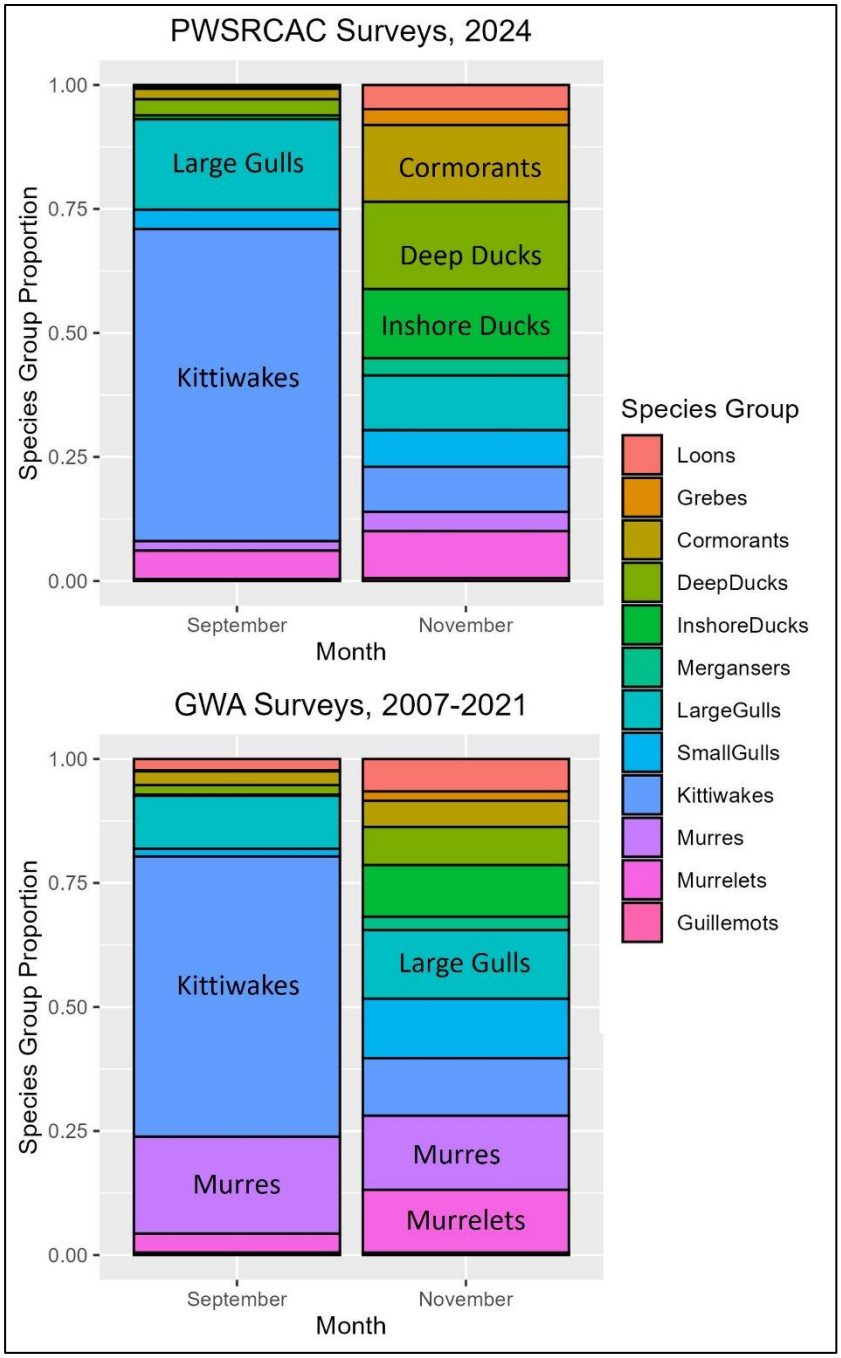

Figure 3. Marine bird species group composition in PWS by month and survey. Most abundant species groups are labeled. Top: PWSRCAC 2024 surveys. Bottom: 2007-2021 GWA surveys.

to mass mortality and reduced breeding success, or complete breeding failures, of common murres and the population has yet to recover (Piatt et al. 2020, Renner et al. 2024).

We found notable differences between the early winter PWSRCAC and GWA transects (Figure 3). In November 2024, cormorants, deep-diving ducks, and inshore ducks were the dominant species observed during surveys. In contrast, during the 15 years of GWA early winter surveys, the three most abundant species were murres, murrelets, and large gulls. We suggest these differences in species composition likely result from variations in migratory movements and the surveyed habitats. Both the deep-diving ducks and inshore ducks breed on inland lakes and wetlands, migrating to shallow coastal waters close to land for winter. The GWA surveys covered a much larger area of PWS, often in deeper, more pelagic waters, whereas the PWSRCAC surveys are more concentrated in bays and nearshore areas. In particular, Port Valdez, a bay never surveyed as part of the GWA surveys but with two transects as part of our PWSRCAC surveys, attracts large numbers of inshore ducks due to its extensive mudflats and shallow nearshore waters. Additionally, its harbor and the Valdez Marine Terminal provide numerous docks and structures that attract cormorants for roosting.

Marine Mammals

In addition to marine birds, we also recorded marine mammals within the 300-m strip during the surveys. When possible, we recorded marine mammal observations out to 1 km, however detectability varied by species as whales are much easier to observe at longer distances compared to sea otter (*Enhydra lutris*), harbor seal (*Phoca vitulina*), Steller sea lion (*Eumetopias jubatus*), or porpoises (*Phocoenoides dalli* or *Phocoena phocoena*). Observations recorded beyond the 300-m strip should be considered minimum counts for these species in these areas.

Sea otter was the most abundant marine mammal observed during both the fall and early winter surveys. Sea otters were recorded in small groups (range =1-15 individuals) and were widespread, occurring on or near 8 of 11 September transects and 10 of 12 November transects. No sea otters were recorded during either survey at Naked Island and the offshore central PWS, nor were they observed on or near the northwest Hinchinbrook Island transect in September (Table 4, Figure B-2).

In September, we observed seven harbor seals, including three seals on or near the nearshore Port Valdez transect and three at Hinchinbrook Entrance (Port Etches n = 2; Zaikof Bay n = 1; Table 4, Figure B-4). In November, eight of the nine seals recorded were observed at Hinchinbrook Entrance (Zaikof Bay, n = 5; Port Etches n = 3; Figure B-4). No Dall's porpoise was observed on September surveys. In November, one pod of six Dall's porpoise was observed near the Tatitlek Narrows transect (Table 4, Figure B-5). We recorded Steller sea lions during both September (n = 24) and November surveys (n = 73; Table 4). Both months, sea lions were observed at Port Etches in Hinchinbrook Entrance

Table 4. Total number of marine mammals observed by species and number of marine mammals observed beyond the 300-m survey strip (denoted in parentheses) on PWSRCAC transects during September (Sep) and November (Nov) 2024. Only summaries for November 2024 include data from the Knowles Head transect. No harbor porpoise or killer whales were observed during either survey.

Common name	Scientific name	Count within 300-m (count beyond) Sep	Count within 300-m (count beyond) Nov
Dall's Porpoise	*Phocoenoides dalli*		0 (6)
Harbor Seal	*Phoca vitulina*	2 (5)	7 (2)
Humpback Whale	*Megaptera novaengliae*		1 (1)
River Otter	*Lontra canadensis*		2
Sea Otter	*Enhydra lutris*	99 (123)	90 (50)
Steller Sea Lion	*Eumetopias jubatus*	18 (6)	7 (66)
Grand Total		119 (+134)	107 (+125)

and in Port Valdez. However, during November most sea lions were recorded at Port Etches (Figure B-3). Interestingly, we observed no killer whales (*Orcinus orca)* during either September or November surveys. Humpback whales (*Megaptera novaengliae*) were observed during November surveys, up around Tatitlek Narrows (n = 2; Figure B-1).

Conclusions and Recommendations

Black-legged kittiwake was the most abundant species on the September transects and were found on all transects. This was to be expected as there are four colonies in Port Valdez representing over 3,000 nesting pairs (D. Irons, unpubl. data). Compared with previous GWA surveys, the relatively smaller proportion of common murre and murrelets and relatively larger proportion of inshore and deep-diving ducks are likely because our previous GWA surveys transects covered a much larger area of the Sound and were often located in deeper, more pelagic waters compared to the nearshore, bay-centric PWSRCAC surveys.

During this first year of fall (September) and early winter (November) PWSRCAC surveys, we identified multiple areas of consistently high and low marine bird densities and other areas that warrant continued evaluation. Because marine bird density and distribution can vary widely across years, multiple years of surveys are necessary to understand natural variation. The highest densities of birds were recorded in bays and nearshore areas (e.g., head of Port Valdez, Zaikof Bay), while the lowest densities were recorded in exposed

and/or deep, offshore habitats (Valdez Arm and central PWS transects). These results are consistent with patterns observed during the GWA surveys that marine birds in PWS tend to prefer shallow and protected habitats that are closer to shore compared to deep, offshore habitats or exposed habitats (Dawson et al., 2015; Stocking et al., 2018; Schaefer et al., 2020; Schaefer and Bishop, 2023).

The September and November 2024 results provide further support for special protection of the marine and nearshore waters around the head of Port Valdez as well as the bays and island coastlines around Hinchinbrook Entrance. These two areas host consistently high numbers of marine birds and marine mammals, including species that have yet to recover from the 1989 Exxon Valdez oil spill. Importantly, the head of Port Valdez is vulnerable to disturbance because of the proximity to human infrastructure, including the Valdez Marine Terminal, harbor, and fuel dock. Hinchinbrook Entrance is particularly vulnerable to anthropogenic disturbance because it is where tankers enter and exit PWS and because of the importance of Porpoise Rocks to marine wildlife. Compared to other surveyed areas, Hinchinbrook Entrance also supports high numbers of marbled murrelets and pigeon guillemots (Figures A-11, A-12), two species that were injured by Exxon Valdez spill and whose populations have not yet recovered (EVOSTC 2014).

Our survey results can be used to update oil spill response planning tools and refine response efforts in and around the tanker escort lane during the non-breeding season. As with our March 2021-2023 PWSRCAC survey data we will submit the fall and early winter data for inclusion in National Oceanic and Atmospheric Administration (NOAA) Environmental Response Management Application (ERMA) annually. ERMA is an online tool to aid resource managers to make informed decisions for environmental response, damage assessment, and recovery/restoration. Our data could also be used to update the NOAA Environmental Sensitivity Index (ESI) maps, which are used by responders, managers, and planners to identify coastal resources at risk in the case of oil or chemical spills. Unfortunately, the ESI maps for PWS are over 20 years old and contain very limited winter bird and mammal information for many of the areas identified here or previously for prioritized protection (e.g., Zaikof Bay, Rocky Bay, Port Etches, northwestern Hinchinbrook Island coastline, Port Gravina, Port Fidalgo, Tatitlek Narrows, Port Valdez).

Our surveys do not include all areas that potentially may be impacted by an oil spill, nor do they capture all the variation in marine bird phenology, species composition, and habitat use across the nonbreeding season. With that said, continued monitoring in and around the tanker escort lane is important for understanding marine bird and marine mammal vulnerability to environmental change and anthropogenic disturbance and could be used to update oil spill response planning tools and refine response efforts during the non-breeding season.

Literature Cited

Dawson, NM, Bishop, MA, Kuletz, KJ, and Zuur, AF. 2015. Using ships of opportunity to assess winter habitat associations of seabirds in subarctic coastal Alaska. Northwest Science 89: 111–128.

Exxon Valdez Oil Spill Trustee Council. 2014. 2014 Updated injured resources and services list. Anchorage, Alaska.

Hayward, James L. and N. A. Verbeek. 2008. Glaucous-winged Gull (Larus glaucescens), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; http://bna.birds.cornell.edu.bnaproxy.birds.cornell.edu/bna/species/059

McKnight, A, Irons, DB, Allyn, AJ, Sullivan, KM, Suryan, RM. 2011. Winter dispersal and activity patterns of post-breeding black-legged kittiwakes *Rissa tridactyla* from Prince William Sound, Alaska. Marine Ecology Progress Series 442:241-253. https://doi. org/10. 3354/meps09373.

Piatt JF, Parrish JK, Renner HM, Schoen SK, Jones TT, Arimitsu ML, Sydeman WJ. 2020. Extreme mortality and reproductive failure of common murres resulting from the northeast Pacific marine heatwave of 2014-2016. PloS one 15 e0226087.

R Core Team. 2024. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www. R-project. org/.

Renner HM, Piatt JF, Renner M, Drummond BA, Laufenberg JS, Parrish JK (2024). Catastrophic and persistent loss of common murres after a marine heatwave. Science 386:1272-1276.

Schaefer, A, Bishop, MA, and Thorne, R. 2020. Marine bird response to forage fish during winter in subarctic bays. Fisheries Oceanography 29: 297-308. https://doi. org/10. 1111/fog. 12472.

Schaefer, AL and Bishop, MA. 2023. Long-term monitoring of marine bird abundance and habitat associations during fall and winter in Prince William Sound. *Exxon Valdez* Oil Spill Long-term Monitoring Program (Gulf Watch Alaska) Final Report (*Exxon Valdez* Oil Spill Trustee Council Project 21120114-E), *Exxon Valdez* Oil Spill Trustee Council Project, Anchorage, Alaska.

Stocking, J, Bishop, MA, and Arab, A. 2018. Spatio-temporal distributions of piscivorous birds in a subarctic sound during the non-breeding season. Deep-Sea Research Part II 147: 138-147.

U. S. Fish and Wildlife Service. 2007. North Pacific pelagic seabird observer program observer's manual, inshore/small vessel version, November 2007. U. S. Fish and Wildlife Service, Migratory Bird Management Nongame Program, Anchorage, Alaska. Unpublished protocol manual, 25 pp.

Zuur A. F., N. Dawson, M. A. Bishop, K. Kuletz, A. A. Saveliev, and E. N. Ieno. 2012. Two-stage GAMM applied to zero inflated common murre density data. *In* A. F. Zuur, A. A. Saveliev, and E. N. Ieno (editors), Inflated and Generalized Linear Mixed Models with R. Highland Statistics Ltd. Newburgh, United Kingdom. Pp. 149-182.

Appendix A. Marine bird density and distribution in Prince William Sound, Alaska, September and November 2024.

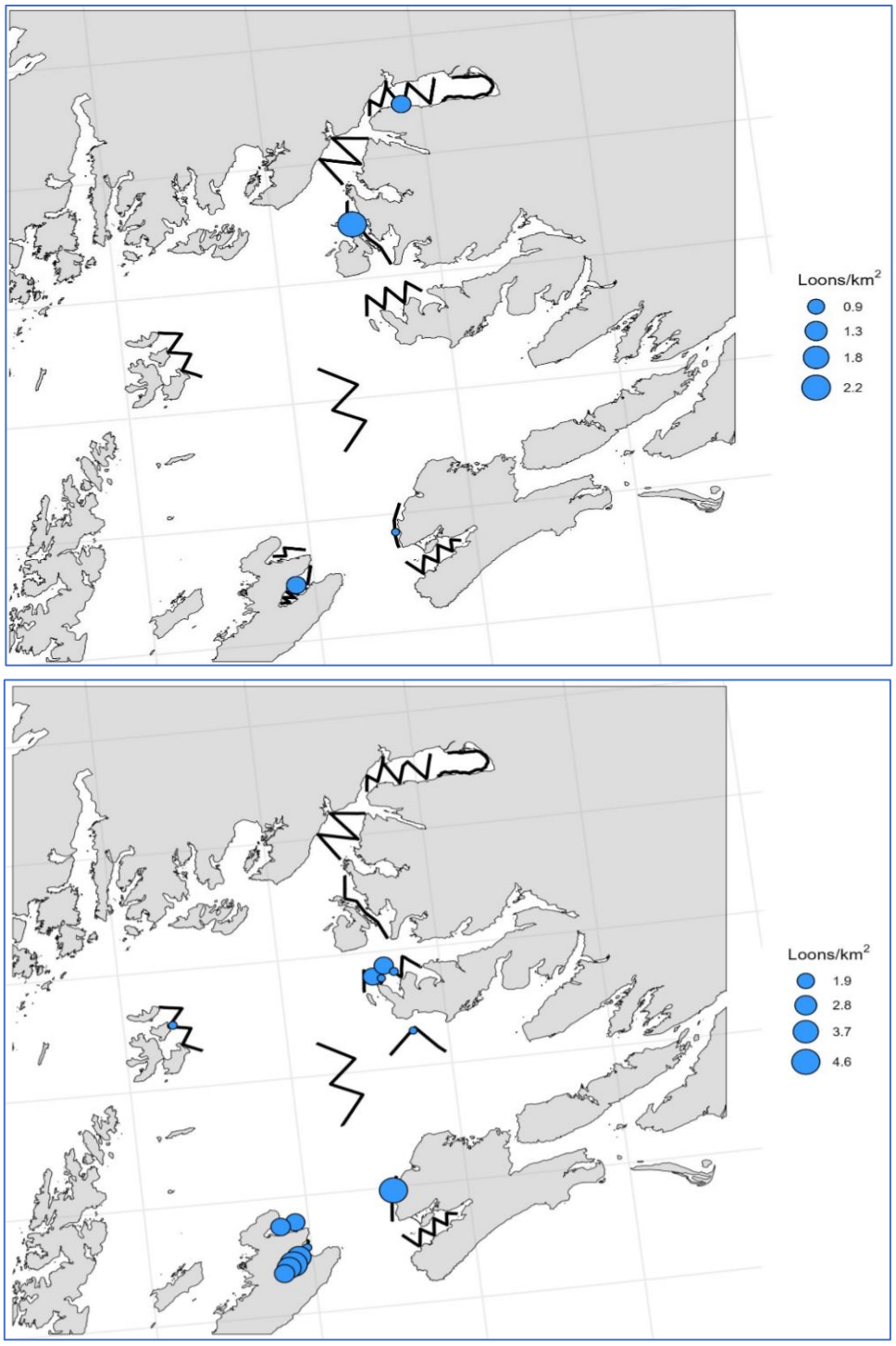

Figure A-1. Distribution of loons (common, Pacific, unidentified) by density (birds/km^2) during September (top) and November (bottom) 2024 surveys.

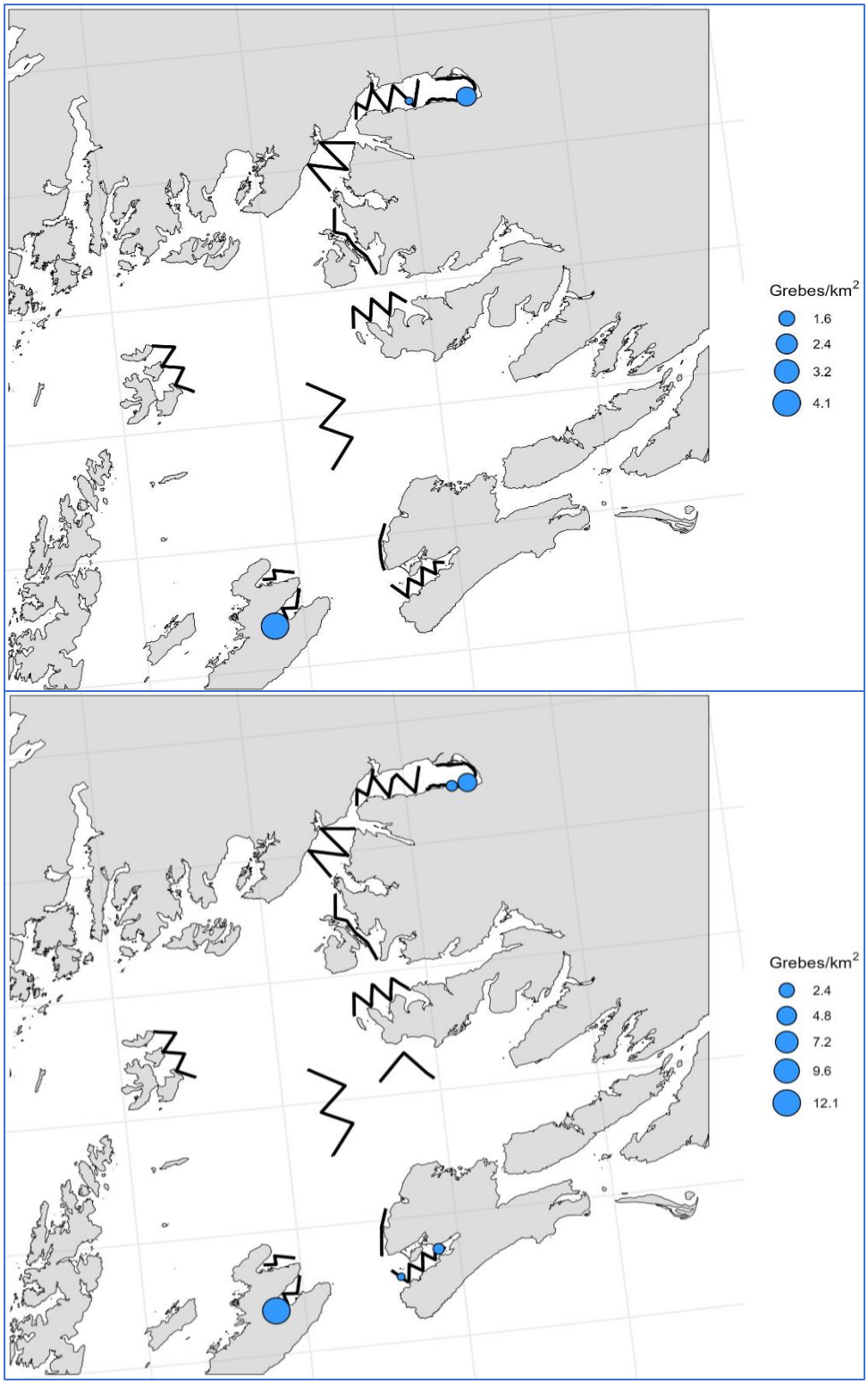

Figure A-2. Distribution of grebes (horned, red-necked, unidentified) by density (birds/km^2) during September (top) and November (bottom) 2024 surveys.

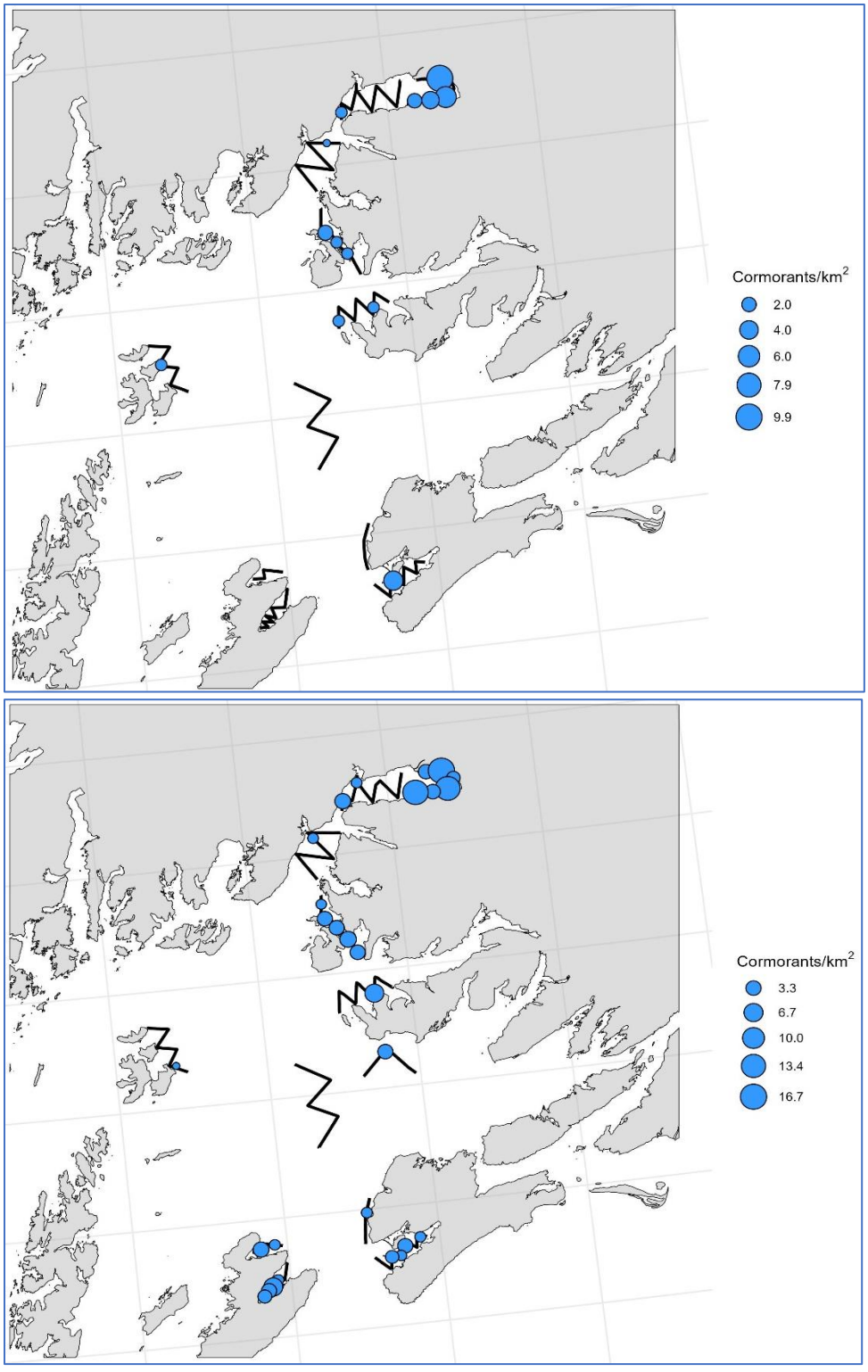

Figure A-3. Distribution of cormorants (double-crested, pelagic, unidentified) by density (birds/km^2) during September (top) and November (bottom) 2024 surveys.

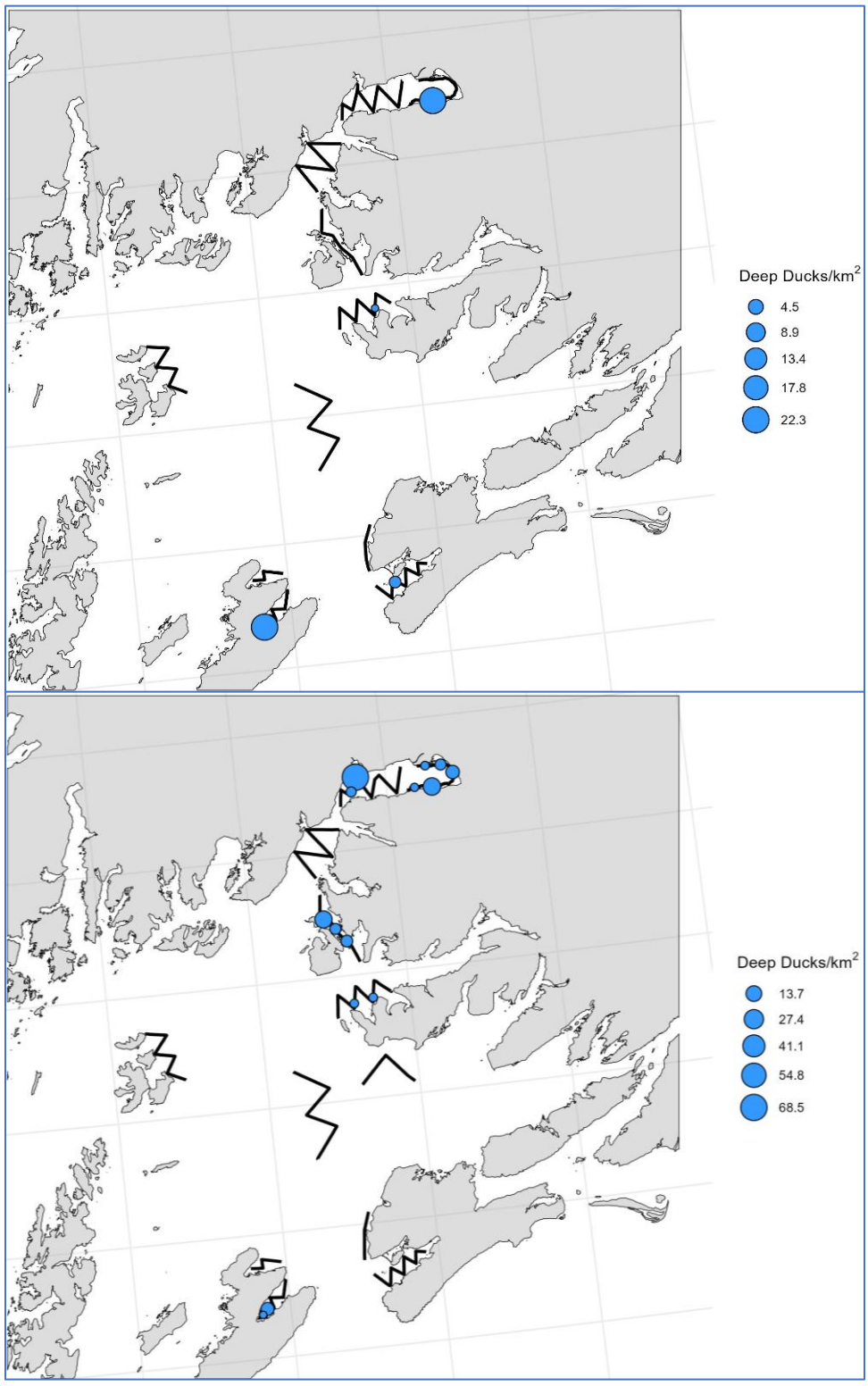

Figure A-4. Distribution of scoters (black, surf, white-winged, unidentified) by density (birds/km^2; top) during September (top) and November (bottom) 2024 surveys.

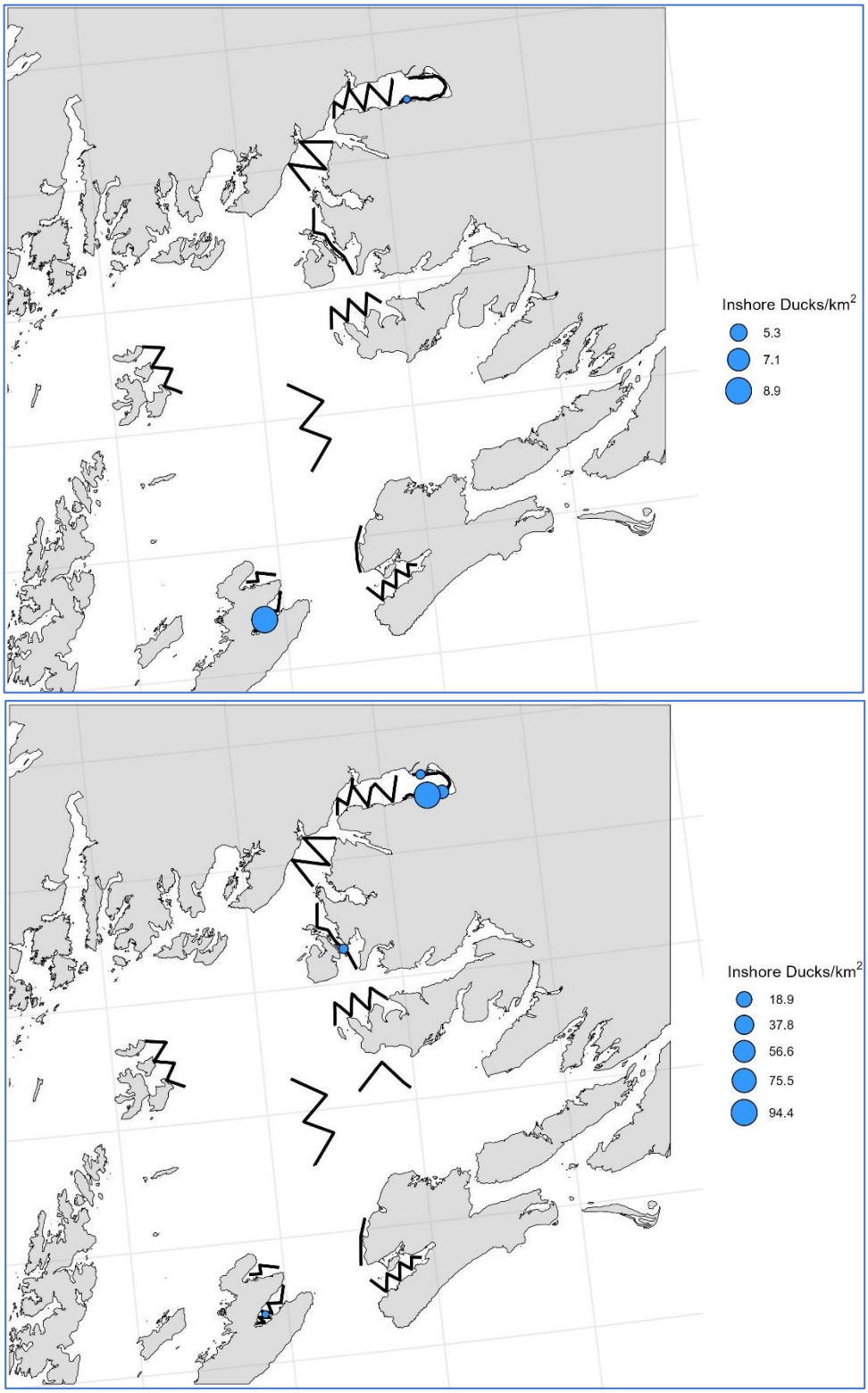

Figure A-5. Distribution of inshore ducks (Barrow's goldeneyes, common goldeneyes, unidentified goldeneyes, buffleheads) by density (birds/km^2) during September (top) and November (bottom) 2024 surveys.

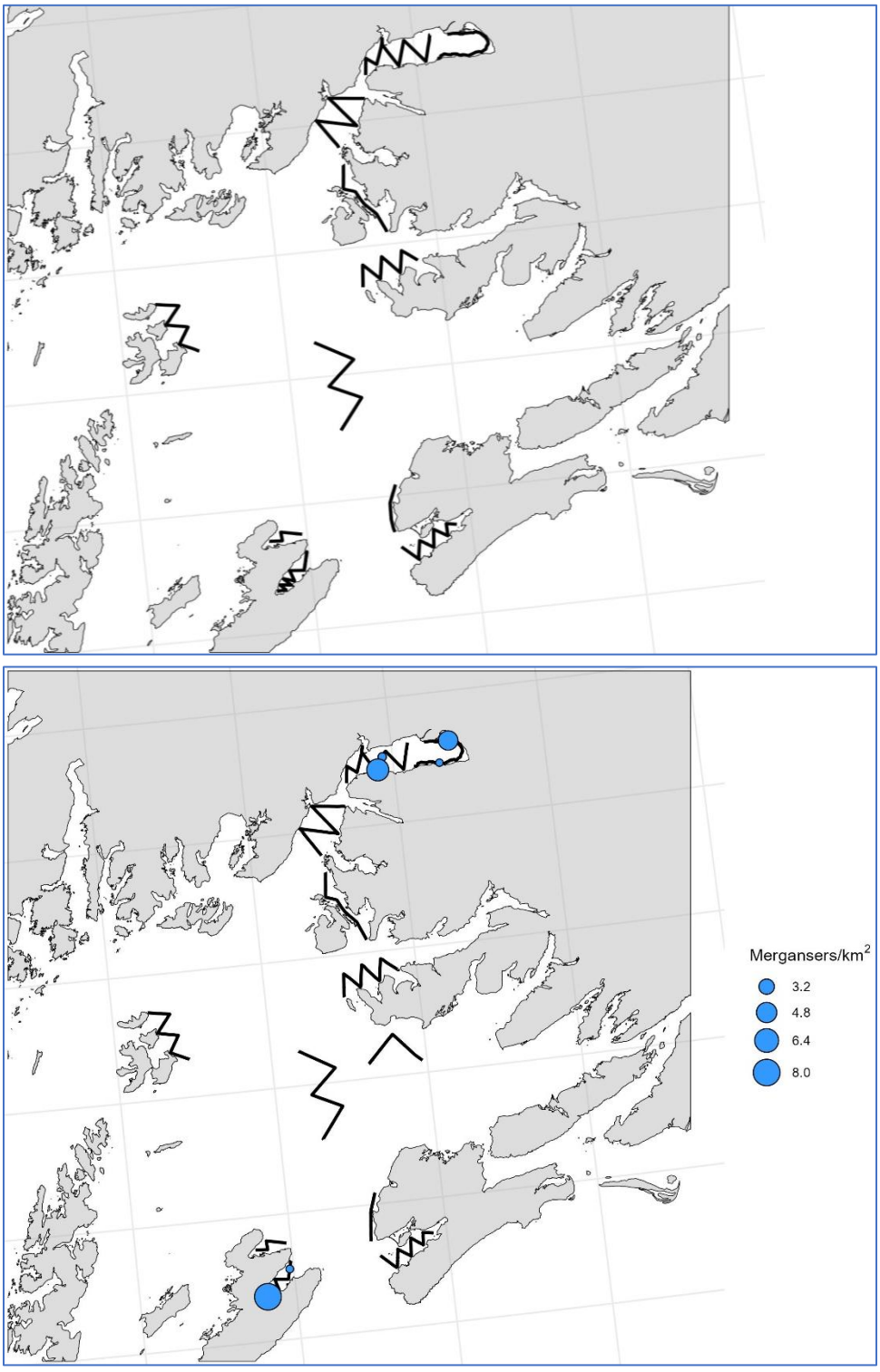

Figure A-6. Distribution of mergansers (common, red-breasted, unidentified) by density (birds/km^2) during September (top) and November (bottom) 2024. Note, no mergansers were observed on transect during September 2024.

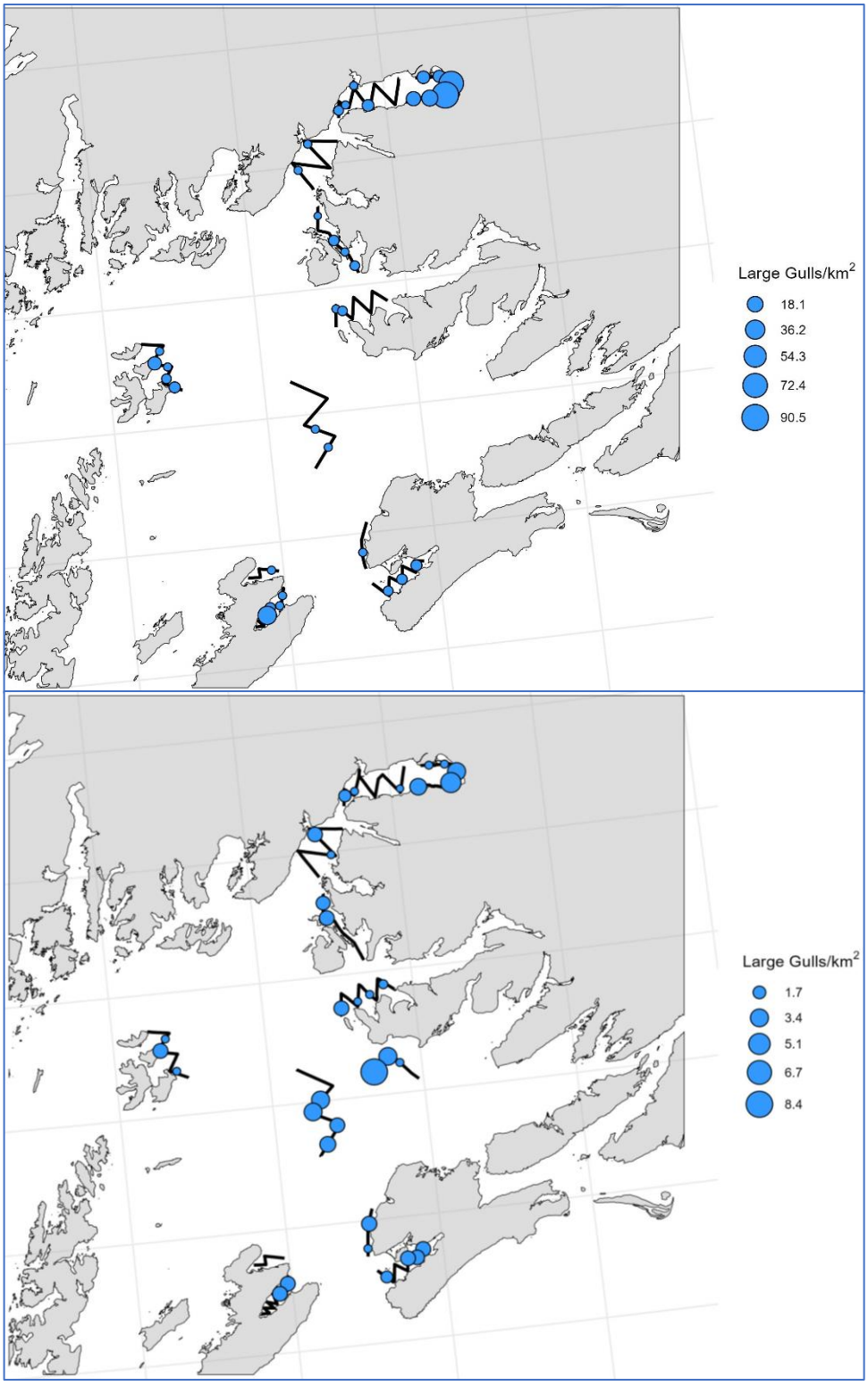

Figure A-7. Distribution of large gulls (glaucous-winged, herring, unidentified) by density (birds/km^2) during September (top) and November (bottom) 2024.

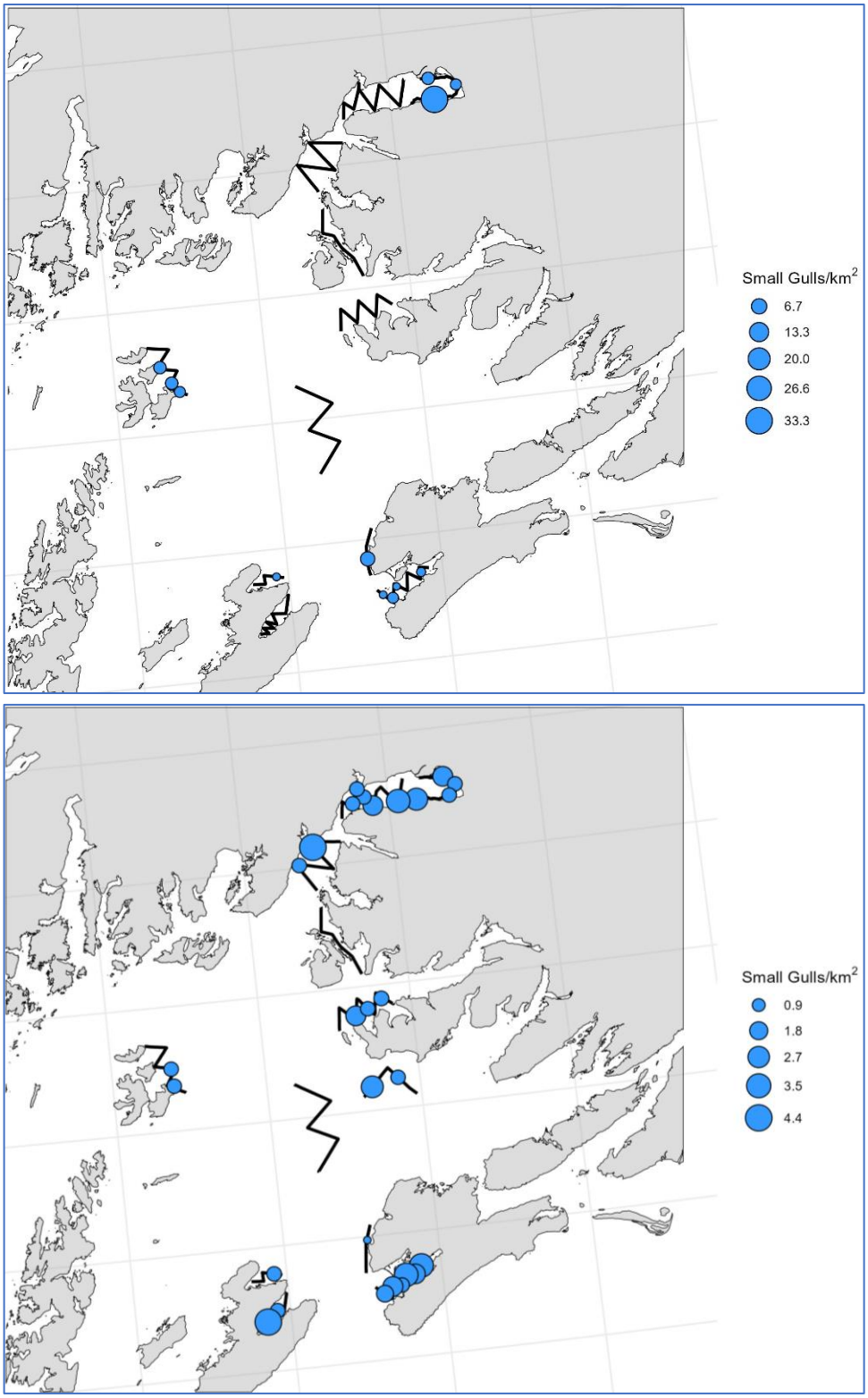

Figure A-8. Distribution of small gulls (short-billed, unidentified) by density (birds/km^2) during September (top) and November (bottom) 2024 surveys.

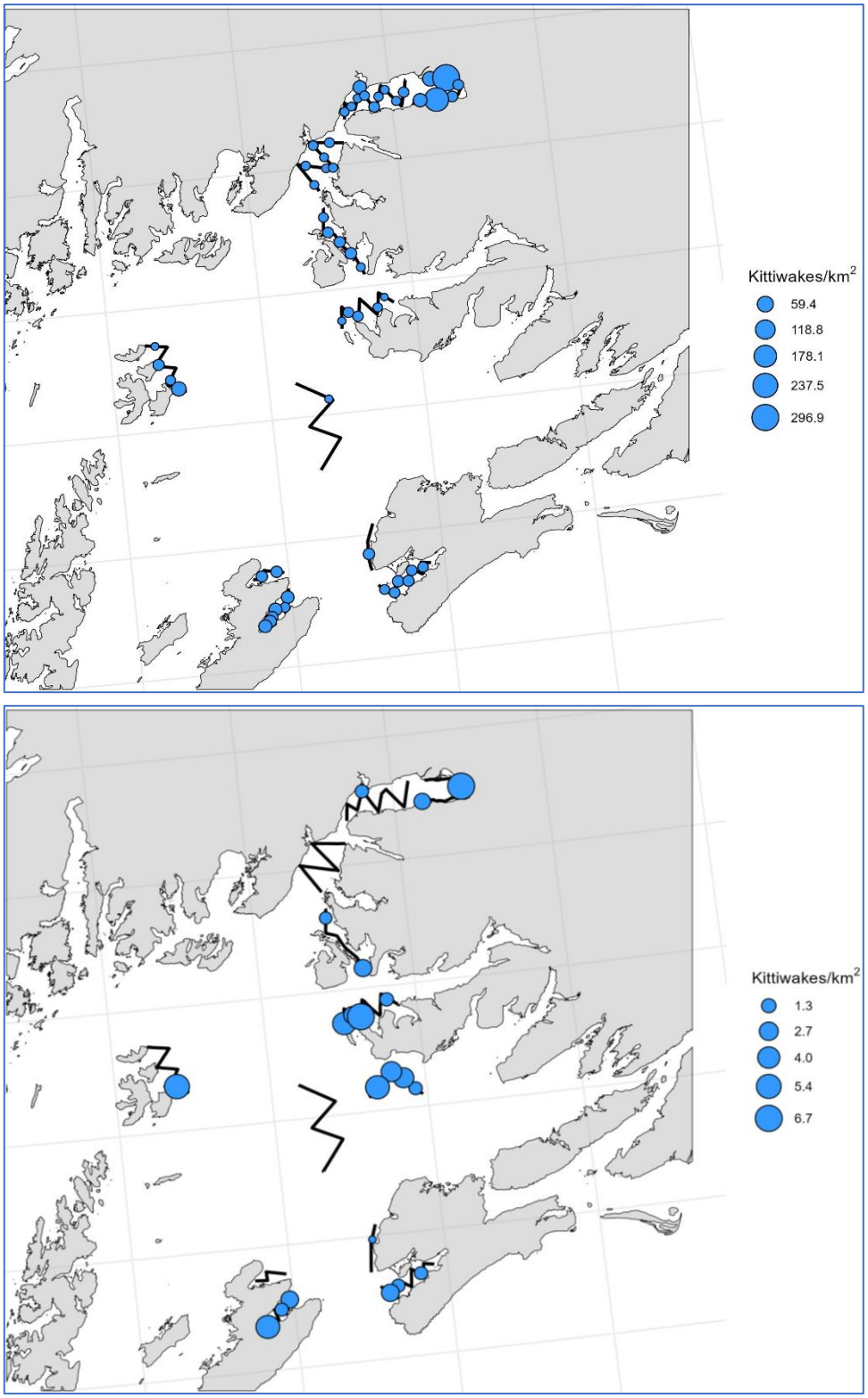

Figure A-9. Distribution of black-legged kittiwakes by density (birds/km$^{2)}$ during September (top) and November (bottom) 2024 surveys.

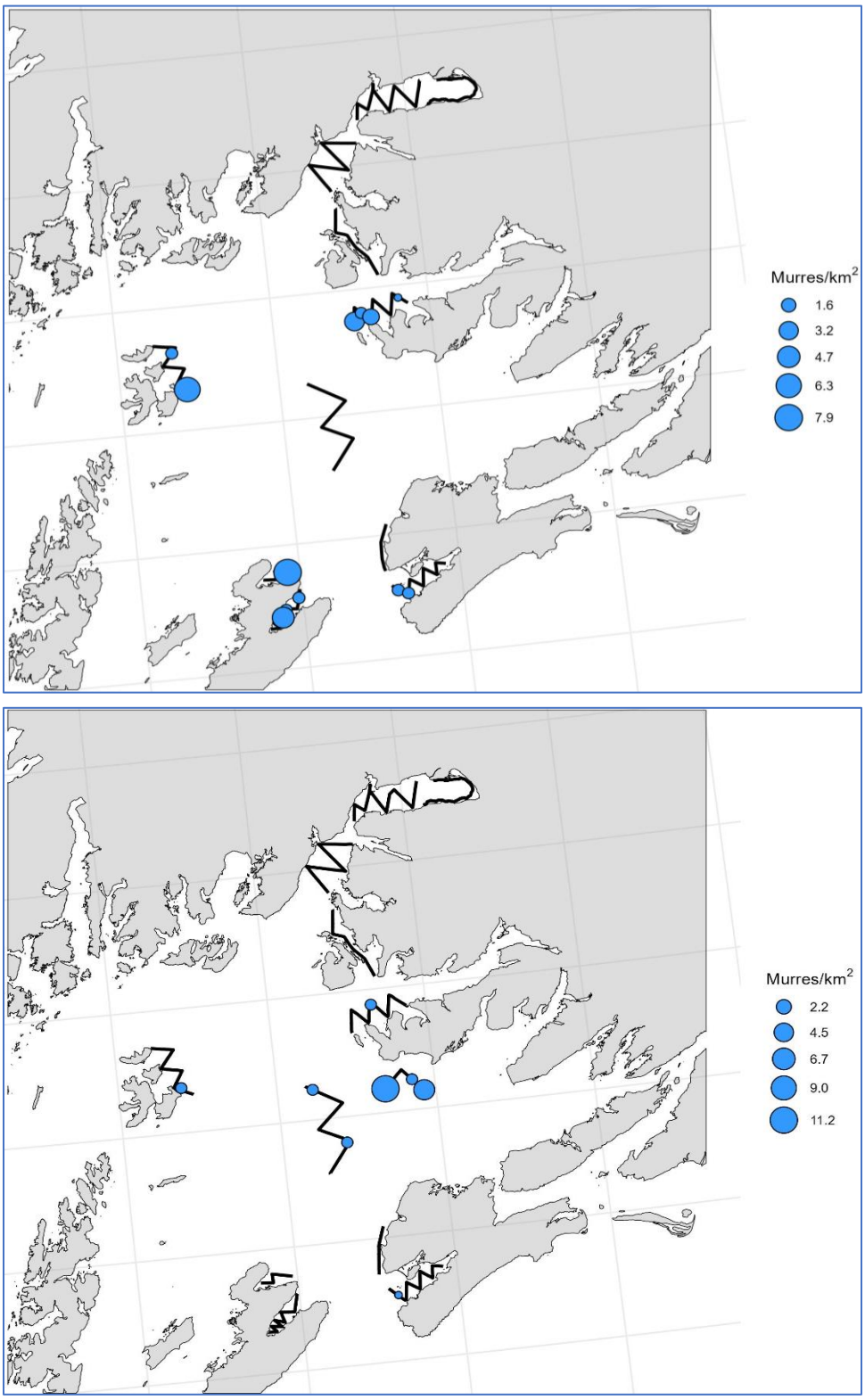

Figure A-10. Distribution of common murres by density (birds/km^2) during September (top) and November (bottom) 2024 surveys.

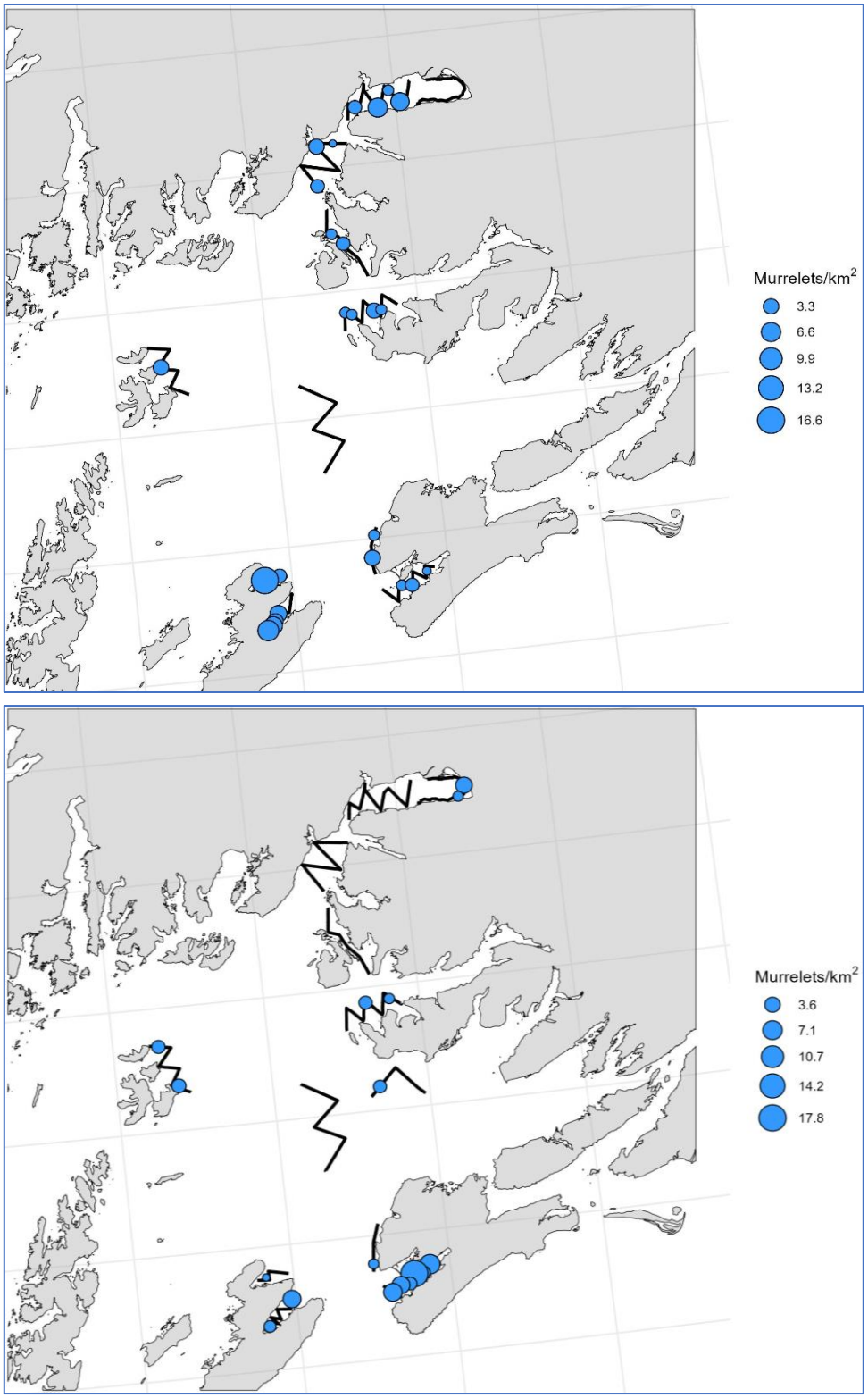

Figure A-11. Distribution of murrelets (marbled, unidentified) by density (birds/km^2) during September (top) and November (bottom) 2024 surveys.

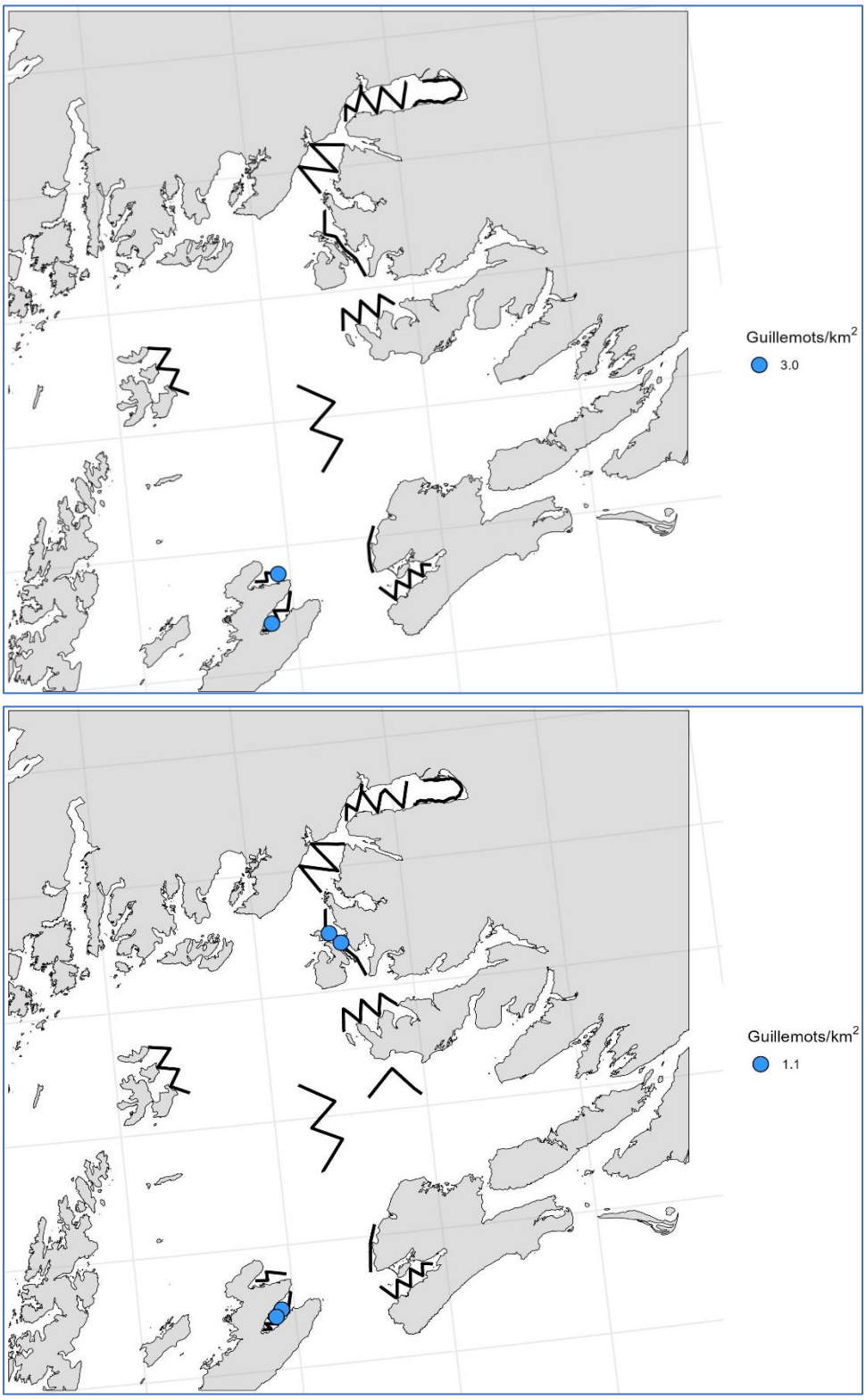

Figure A-12. Distribution of pigeon guillemots by density (birds/km^2) during September (top) and November (bottom) 2024 surveys.

Appendix B. Marine mammals observed by species and location, September and November 2024.

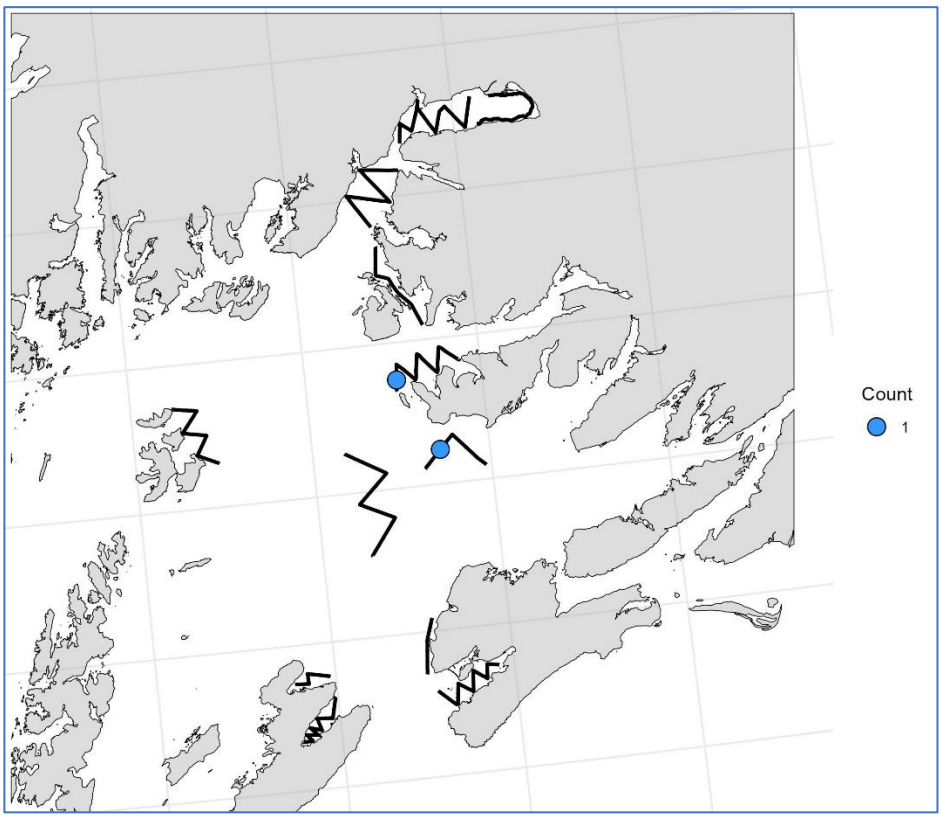

Figure B-1. Distribution and count of humpback whales observed during November 2024 surveys. No whales were observed during the September 2024 surveys.

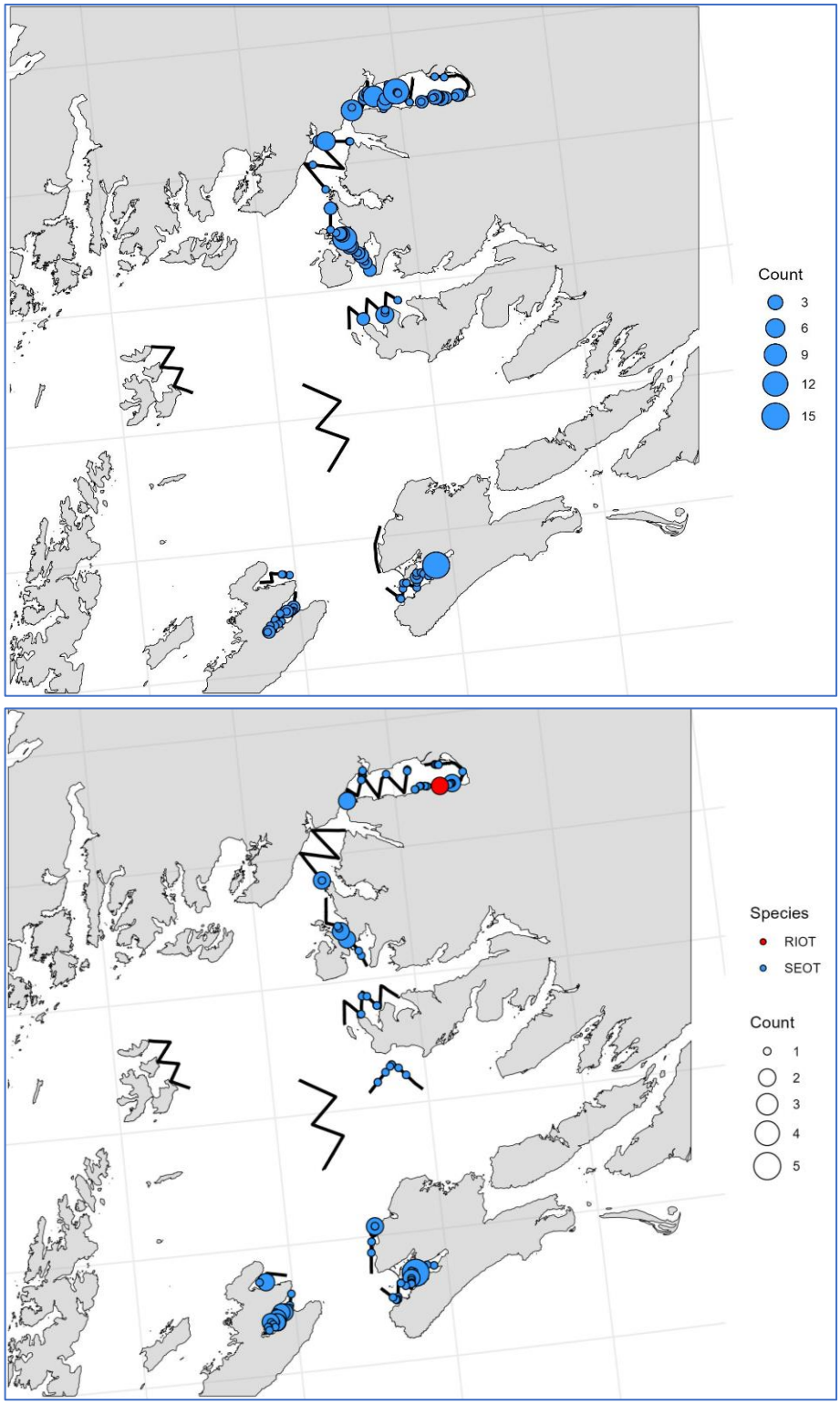

Figure B-2. Location and count of sea otters (SEOT) and river otters (RIOT) observed during September (top) and November (bottom) 2024 surveys.

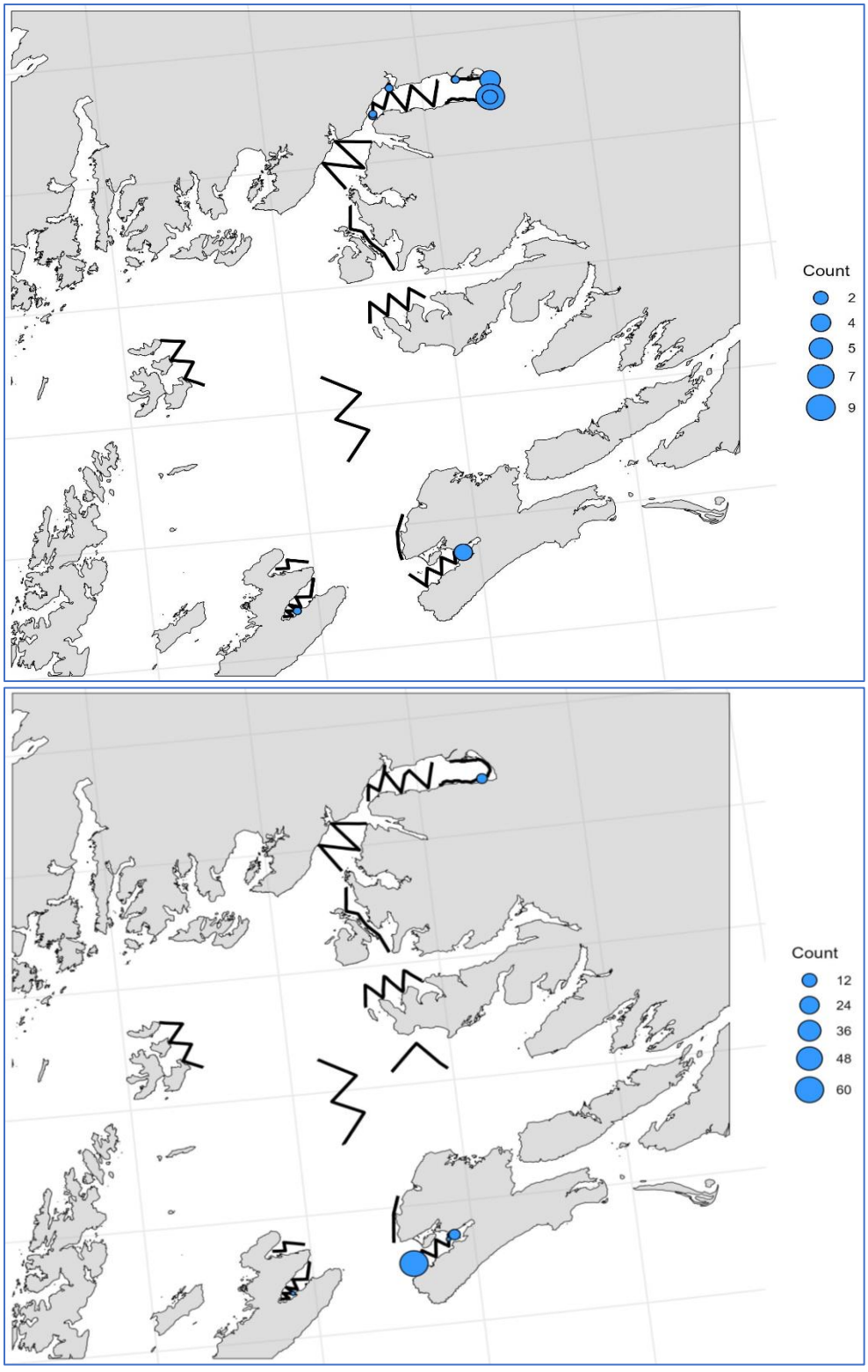

Figure B-3. Location and count of sea lions observed during September (top) and November (bottom) 2024 surveys.

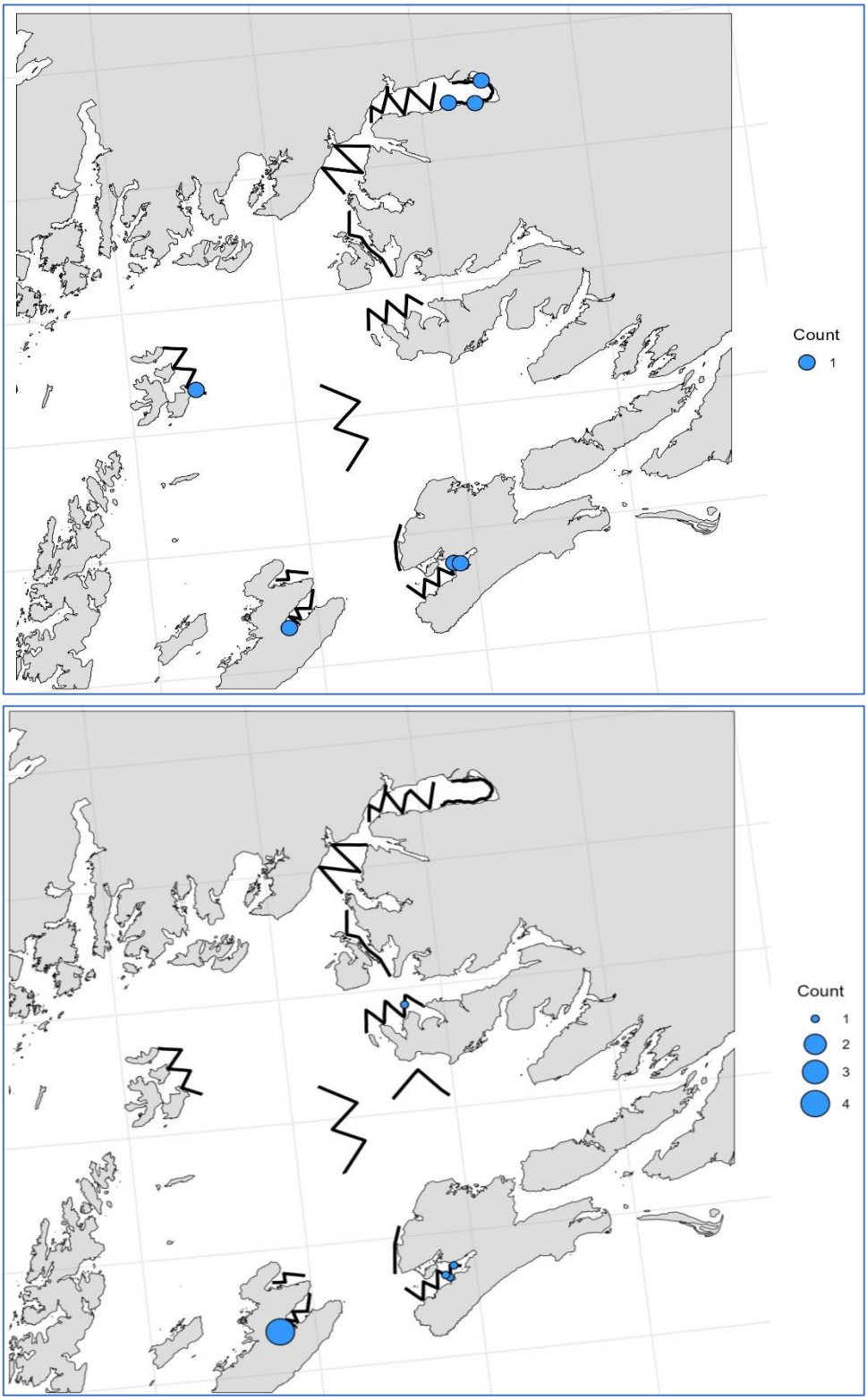

Figure B-4. Location and count of Harbor Seals observed during September (top) and November (bottom) surveys.

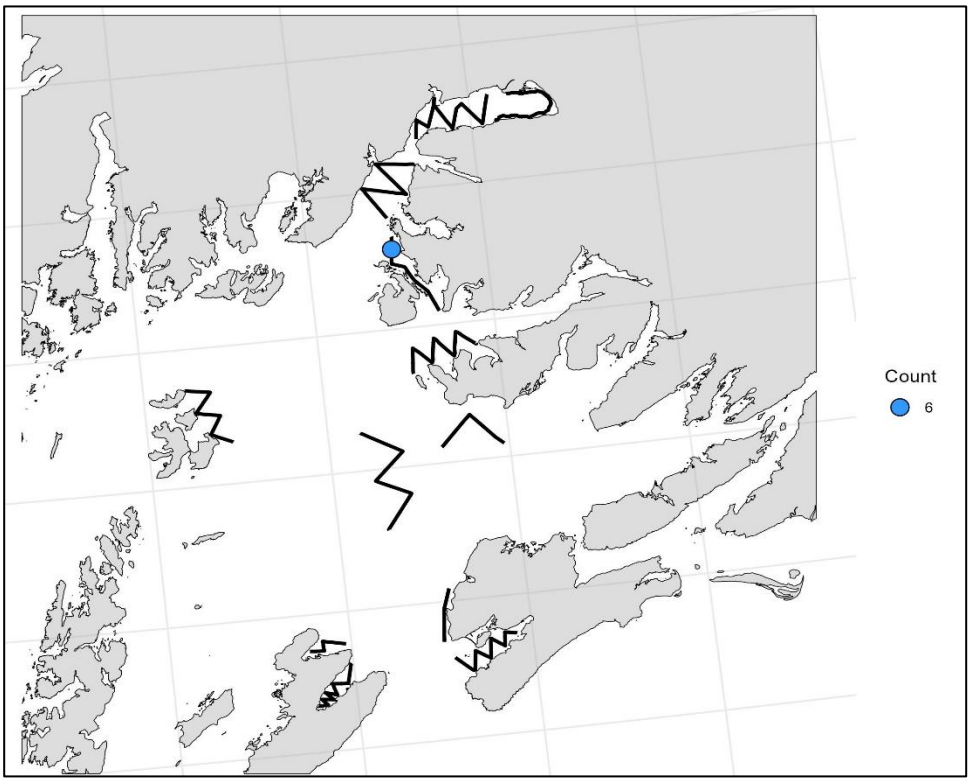

Figure B-5. Location and count of Dall's Porpoises observed during November 2024 survey. No porpoises were observed on the September 2024 survey transects.